it must be admitted that it is precisely through this exceptional character of her attainments that her case may be adduced in proof of the rule that women are not by nature adapted for studies which involve the higher processes of induction and analysis. If such powers as hers had been more generally granted to women, why is she the only woman on record amongst us who has exhibited them?

There was nothing exceptional in her bringing up, or her opportunities. In fact, no woman of her time and station could have had a more typical experience of life than she had. She was born nearly a century ago, in 1780, and spent her childhood and youth in Scotland, within an ordinary circle of the upper middle-class society of her age and country, and therefore very closely circumscribed by lines of defence against innovations and social changes of any kind. Her father, Captain Fairfax (a brave officer who commanded the *Repulse* during the war), received the news of her having taught herself the first six books of Euclid with the remark—"We must put a stop to this, or we shall have Mary in a strait-jacket one of these days. There was 'X.,' who went raving mad about the longitude!" This gallant captain was, moreover, a genuine good Tory, who took decided views in regard to all questions involving a departure from established precedents, and when his young daughter ventured to express her admiration for the short-cut hair, which was then the badge of a Liberal in politics, he exclaimed, "By G—, when a man cuts off his queue the head should go with it." Her mother, who found all her intellectual cravings amply satisfied with the reading of her Bible, a volume of sermons, and a stray copy of a newspaper, fully concurred in her husband's views of the education suited to young women, and was at great pains to thwart her daughter's unladylike taste for pursuits regarded at the time as the exclusive privileges of men, and to keep her mind and hands closely fettered by the bonds of a household possessed of very limited pecuniary means. The parents of the future authoress of the "Connection of the Physical Sciences" did not, therefore, afford her special facilities for mastering any of those higher branches of knowledge for which she seems to have had an instinctive yearning almost before she knew their names. Indeed, at the age of 10, Mary Fairfax was still a little ignorant savage, running wild over the hills and braes of Burntisland, and scarcely knowing her letters; yet before she was 13 she had surreptitiously possessed herself of some of her brother's books and taught herself Latin enough to construe "Cæsar's Commentaries." At that time she scarcely knew the simplest processes of arithmetic, but at the age of 17 the possession of a copy of "Bonnycastle's Algebra," procured for her by her uncle and future father-in-law, Dr. Sutherland—the only one of her relations who did not absolutely oppose her efforts to acquire knowledge—enabled her to solve the mystery of the X's and Y's; and from that hour till the day of her death, mathematics, in one shape or other, may be said to have formed part of her daily existence. For more than half a century they were the staple occupation of her morning hours when the duties of her house and family had been disposed of; at a very advanced age she began and mastered the study of Quaternions, and other forms of modern mathematics, and at 89 she "still retained facility in the calculus."

The restless activity of her intellect had indeed never slumbered. When she received her first lessons in painting and music, she had begun at once to try and trace out the scientific principles on which these arts are based, and never rested till she had gained some knowledge of the laws of perspective and of the theory of colour, and had learnt to tune her own instruments. In later years she may be said to have been always in the van of discovery—not indeed as an originator but as the readiest and aptest of students—and from the time when Young showed her how he conducted the experiments by which he claimed to have discovered the undulatory theory of light, and Wollaston made her one of the very first witnesses of the seven dark lines crossing the solar spectrum, whose detection laid the basis of some of the most wonderful cosmical discoveries of this or any age, Mary Somerville, to the last day of her long life of nearly 92 years, followed with quick and appreciative understanding every step in the advance of modern research. Age could not quench the fire of her intellect, and even in her 92nd year, when the Blue Peter, as she quaintly remarks, had long been flying at her foremast, and she had soon to expect the signal for sailing, she could interest herself in the phenomena of volcanic eruption, speculate on their effects, and follow with lively sympathy the progress of scientific inquiry, and the issues of passing events.

In reading the personal recollections of this wonderful woman nothing strikes one more than the ordinary and even commonplace conditions under which her great intellect advanced to maturity. In her case the only exceptional features were her natural gifts and her perseverance in cultivating them; and this is precisely the point that should not be lost sight of. Mary Somerville will always present a noble instance of what a woman has been capable of achieving, but it would be straining the argument too far to say that we are justified from her special case to draw general conclusions in regard to women's aptitude for the study of the higher forms of physical science.

EXTINCT VERTEBRATE FAUNA OF THE UNITED STATES

Contributions to the Extinct Vertebrate Fauna of the Western Territories of the United States. By Prof. Joseph Leidy. (Government Printing Office, Washington.)

THIS important volume is the first of five which are to form the "Report of the United States Geologica Survey," and it will be supplemented by a memoir, embracing the same subjects, by Prof. Cope.

The large field for palæontological work recently opened up in the Western Territory of the United States has been as fruitful in the introduction of new and unexpected forms of extinct vertebrate life, as that so ably worked out by Cuvier, the Paris basin. By the establishment of a military station at Fort Bridger, opportunities have been afforded to geologists, which the offensive attitude of the Indian tribes had previously deferred, rendering inaccessible a district, the richness of whose past fauna must have been as remarkable as is its present desolation.

Fort Bridger is a military post about 100 miles E.N.E. of Great Salt Lake City, in the south-west corner of the Wyoming Territory. The valley in which it is situated stands nearly 7,000 ft. above the level of the sea at the base of the Uintah Mountains, which form its southern boundary; the Wind River Range defining it on the north-east, and the Wahsatch Mountains on the west separating it from the Great Salt Lake. The enclosed plain is evidently the remains of an extensive fresh-water lake, which in the Eocene period must have abounded with animal life, and whose borders must have been the haunts of animals, both huge and small, which lived and died by its marshy banks. Green River now runs through the plain, and it, with its smaller tributaries, by cutting up the easily eroded deposit, produces a scenery of a most peculiar character, consisting of flat-topped hills and cliffs, with perpendicular sides, and often most grotesque proportions. Those of the water-courses which do not dry up during the summer months are fringed with vegetation, such as cotton-wood, willow and aspen trees, but most of the country is treeless and barren, reminding the spectator more of the ruins of a colossal city, than of any other existing scenery.

The flat-topped hills, table-lands, and scarp-rocks are termed "buttes," and the fossils are generally found at their bases, having fallen there from the gradual atmospheric disintegration of their sides, along with the *débris* of the deposits. The fossils consist mostly of the bones and teeth of vertebrata, together with lacustrine shells. The bones are generally black or brownish, sometimes yellowish; they are generally distorted and much broken, except the small ones, such as those of the carpus and tarsus. They do not withstand the action of the air at all well.

The remains of mammals, which are very abundant, are mostly of genera which are not found elsewhere. Several, however, approach those of the Paris tertiary basin. The odd-toed Ungulata, or Perissodactyla, are particularly numerous, whilst even-toed Ungulate or Artiodactyla are as remarkably few. True Proboscidians are not found, but if Prof. Marsh is correct in placing Dinoceras in an order by itself, animals equally huge, of an independent type, were far from uncommon. Most of the other mammalian orders are most probably represented, though much has yet to be done in the identification of specimens.

Prof. Leidy has not yet seen any remains of bird, but we, some time ago, called attention to Prof. Marsh's discovery of *Odontornis*, a bird with well-developed teeth in both jaws; quite different from *Odontopteryx* of Owen, which has not true teeth, but teeth-like processes of the jaws.

The remains of turtles are most numerous; many of them were aquatic, and some belong to genera which cannot be distinguished from those now existing. What is also particularly interesting to note is that the remains of Crocodilia, which are not very abundant, are all derived from species of true *Crocodilus*, the old-world form, with the lower so-called "canines" fitting into a notch in the upper jaw, and not from *Alligator*, the genus which is now found in the Mississippi and its neighbourhood, with the lower "canine" fitting into a maxillary socket.

From the large amount of material which has passed through his hands, most of which is deposited in the Museum of the Academy of Natural Science of Philadelphia, there are some types of animals which Prof. Leidy has been able to work out in sufficient detail to make his results of general interest. Perhaps the most complete of these is *Palæosyops*, a perissodactylate Ungulate, of about the size of the Tapir, portions of the bones and nearly complete sets of the teeth of which have been several times discovered. The dental formula was complete, the typical forty-four teeth being present, all close together in the usual numbers, namely i. $\frac{3-3}{3-3}$, c. $\frac{1-1}{1-1}$, p.m. $\frac{4-4}{4-4}$, m. $\frac{3-3}{3-3} = 44$. The canines were peculiarly large, having much the same proportions as in an average carnivorous animal, like the bear. The molars have a resemblance to *Palæotherium*, the inner lobes of the crowns of the upper molars being, however, more completely isolated. There was a third trochanter to the femur, and three toes, as in the Tapir, were present on the hind feet. *Palæosyops paludosus* is the most common species. It is not known whether the neck was long and curved, as that of *Palæotherium* is now found to have been, or whether it was short and straight, as in the Tapirs. *Limnohyus* is a closely allied genus, named by Prof. Marsh.

Another perissodactylate, *Hyrachyus*, closely resembles *Lophiodon* of France, but has an extra premolar in the lower jaw, and a lobe less in the last lower true molar.

Perhaps *Trogosus* is one of the most interesting of the extinct mammals from the "Mauvaises Terres." It is also perissodactylate, and slightly smaller than the common pig. Its dentition would almost lead to the idea that the long-missing form which may be supposed to connect the Ungulata with the Rodentia, has at last been discovered; for with the usual complement of molar teeth there are no canines, and a huge pair of rodent-like incisors, which, in the lower jaw at least, had an intermediate pair of very small teeth. The large incisors had *persistent pulps*, and were formed in part of a circle; they wore down obliquely, in the same way as in the Cavies; were grooved longitudinally, somewhat as in *Aulacodus*, and were covered with enamel on the anterior surfaces only.

It is not to be wondered at, when small fragments of the skull of an animal so unknown and aberrant as *Uintatherium* (or *Dinoceras* of Marsh) were obtained, that each piece should have been referred to a separate genus and species, and Prof. Leidy, in the latter part of his memoir, puts together, as parts of *Uintatherium*, the tusks, horn-cores, &c., as parts of one and the same animal, which he had considered to be portions of different animals in the earlier part of his work, and which he had no reason for associating until Prof. Marsh had described the complete skull of *Dinoceras mirabilis*, which we figured some time ago. As we also mentioned at the time, Prof. Cope has also named this genus *Eobasileus* and *Loxolophodon*.

Besides the above mentioned, most characteristic forms, some from other territory strata west of the Mississippi River, are described—ungulate, rodent, and carnivorous—many of which are intimately related to those of the Paris basin, and throw further light on them. Prof. Leidy also figures and describes several of the Chelonia and other reptiles which come from the same locality.

The above notice of the results arrived at by American men of Science show that they deserve the careful study of English palæontolologists and geologists, as they have already thrown great light on the fauna of the Tertiary period, and give promise of adding much more to our knowledge of that epoch, so important to the student of the anatomy and classification of the higher vertebrata.

OUR BOOK SHELF

The Laboratory Guide, a Manual of Practical Chemistry for Colleges and Schools, specially arranged for Agricultural Students. By Arthur Herbert Church, M.A. (London: Van Voorst, 1874).

TEACHERS of chemistry will be glad to welcome the third edition of Prof. Church's "Guide," to which much new matter has been added. Being specially adapted for students of agricultural chemistry, the book is necessarily somewhat limited in its scope, but the amount of information conveyed within the small compass of 215 pages is very great, and is moreover lucid and accurate. The book is divided into three portions, the first treating of a chemical manipulation, the second of qualitative analysis, and the third of quantitative analysis. The author's preliminary remarks upon manipulation are excellent, and should be graven upon the mind of every chemical student. In the "Introduction" we are told that the student "must never forget that the experiment is the means, not the end. . . . . Merely to make a coloured precipitate or a flash of bright flame is not the end of experimenting."

These remarks are much to the purpose, and we commend them to the notice of chemists of older growth, as well as to beginners. The sudden introduction of equations on p. 8 without any previous explanation of the meaning of symbolic formulæ appears somewhat unsystematic, but the student is recommended by Prof. Church to attend some course of lectures on inorganic chemistry, and to study the corresponding chapters in Roscoe's Chemistry, at the same time that he is working through the "Guide." As the "Guide" is at present arranged, the student will find this absolutely necessary. The classification of the metals adopted by the author calls for remark—iron and manganese are classed as dyads and aluminium as a triad. Further on it is explained that this last metal is only a pseudo-triad, being in reality a tetrad. Why not class it with the tetrads at once? Hexad metals and pentad metals are ignored altogether, although manganese forms a hexafluoride, arsenic, and antimony, penta-haloid compounds, &c. We must protest also against the use of the words "vinculant," "vinculance," "univinculant," &c. No advantage is likely to accrue to the science from this new phraseology, and the terms "atomicity," "monatomic," "diatomic," &c., which are in general use, express the idea perfectly. The tables for qualitative analysis differ but little from those generally adopted. The quantitative processes for the analysis of natural products, soils, foods, &c., will be found very useful. In addition to the direct benefit arising from the issue of books like the present, there is an indirect benefit for which we ought to be also indebted to Prof. Church—we refer to the expulsion from the market of hastily compiled and inaccurate works by so-called "Science Teachers," such as it has been our duty to condemn on former occasions.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Prof. Tait and Mr. Spencer

AS is shown by the passage from his *Thermodynamics* which he re-quotes, Prof. Tait holds that "Natural philosophy is an experimental, and not an intuitive science. No *à priori* reasoning can conduct us demonstratively to a single physical truth."

I hold, on the contrary, that as there are *à priori* mathematical truths, the consciousness of which results, not from our individual experiences, but from the organized and inherited effects of ancestral experiences, received throughout an immeasurable past; so are there *à priori* physical truths, our consciousness of which has a like origin.

I have endeavoured to show that Prof. Tait himself, by saying of physical axioms that the appropriately-cultivated intelligence sees "*at once*" their "*necessary* truth," tacitly classes them with mathematical axioms, of which this self-evidence is also the recognised character. Further, I have contended that the laws of motion are *à priori* truths of this kind; are enunciated by Newton as such; are adopted from him by Prof. Tait; and are not furnished by Prof. Tait with any such experimental proofs as he asserts are needful for the establishment of physical truths. And I have gone on to show that no experimental proofs of them are possible—that every supposed proof, whether derived from terrestrial phenomena or from celestial phenomena, involves a *petitio principii.*

In the course of the discussion I have examined the reason Prof. Tait gives for asserting that the laws of motion are not to be accepted as valid *à priori.* The reason is that "as the properties of matter might have been such as to render a totally different set of laws axiomatic, *these laws must be considered as resting on convictions drawn from observation and experiment, and not on intuitive perception.*"

The worth of this reason I have tested by asking the origin of Prof. Tait's professed knowledge that "the properties of matter might have been" other than they are. Here is the passage:—

"It will suffice if I examine the nature of this proposition that 'the properties of matter *might have been*' other than they are. Does it express an experimentally-ascertained truth? If so, I invite Prof. Tait to describe the experiments. Is it an intuition? If so, then along with doubt of an intuitive belief concerning things *as they are*, there goes confidence in an intuitive belief concerning things *as they are not.* Is it an hypothesis? If so, the implication is that a cognition of which the negation is inconceivable (for an axiom is such) may be discredited by inference from that which is not a cognition at all, but simply a supposition. Does the reviewer [a critic whose attack I was answering] admit that no conclusion can have a validity greater than is possessed by its premises? or will he say that the trustworthiness of cognitions increases in proportion as they are the more inferential? Be his answer what it may, I shall take it as unquestionable that nothing concluded can have a warrant higher than that from which it is concluded, though it may have a lower. Now the elements of the proposition before us are these:—*As* 'the properties of matter might have been such as to render a totally different set of laws axiomatic' [*therefore*] 'these laws [now in force] must be considered as resting . . . not on intuitive perception:' that is, the intuitions in which these laws are recognised, must not be held authoritative. Here the cognition posited as premiss, is that the properties of matter might have been other than they are; and the conclusion is that our intuitions relative to existing properties are uncertain. Hence, if this conclusion is valid, it is valid because the cognition or intuition respecting what might have been, is more trustworthy than the cognition or intuition respecting what is! Scepticism respecting the deliverances of consciousness about things as they are is based upon faith in a deliverance of consciousness about things as they are not!"

From this passage Prof. Tait has quoted a small part which, standing by itself, appears somewhat strange; but which ceases to appear strange when read along with the rest. In seeking the authority which Prof. Tait has for asserting that "the properties of matter might have been" other than they are, I have tried all possible suppositions; and as he professes to have faith only in experimentally-ascertained truths, I have asked whether this is one; by way of showing, unmistakeably, that in the absence of experimental warrant he must admit it to be, if not a mere hypothesis, then an intuition. Whence results the incongruity I have pointed out.

Prof. Tait says this argument of mine reminds him of a student whose conceptions of algebraic processes were shown by asking—"But what if x should turn out after all *not* to be the unknown quantity?" His imagination suggests to Prof. Tait an analogy too remote for me to perceive; and one which I think few will